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Impaired Sleep and Well-Being in Mothers With Low-Birth-Weight Infants

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Abstract

Objective: To explore relationships between impaired sleep and well-being in mothers with low-birth-weight infants in the neonatal intensive care unit.

Design: Cross-sectional descriptive exploratory design.

Setting: Neonatal intensive care unit in metropolitan Atlanta, GA.

Participants: Twenty second-week postpartum, first-time mothers who had a low-birth-weight infant hospitalized in the neonatal intensive care unit.

Methods: Self-report data were collected for sleep, fatigue, depression, and well-being. Total sleep time, wake after sleep onset, circadian activity rhythms, and light exposure were measured using a wrist actigraph.

Results: Mothers reported clinically significant sleep disturbance and fatigue severity. Actigraphy showed the average nighttime total sleep time was less than 7 hours with 19% ± 2.2% wake after sleep onset, and the total daytime sleep was more than an hour. Mothers also experienced moderate depressive symptoms. Maternal well-being as measured by the Medical Outcomes Short Form-36, version 2 was approximately 1 *SD* below the mean scores of age-matched women in the general U.S. population.

Conclusion: Mothers of hospitalized low-birth-weight infants are vulnerable. The presence of sleep disturbances and negative physical and mental health indicators warrants further study. Intervention is needed to promote sleep for new mothers during postpartum recovery, especially mothers who are dealing with a medically ill infant.

Keywords

mothers; sleep disturbance; postpartum; actigraphy; fatigue; NICU; circadian rhythms; circadian activity rhythms

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Adequate sleep and rest are essential for post-partum women so they can meet the demanding needs of their newborns; however, impaired sleep, such as less nighttime sleep and more wake time after sleep onset, is prevalent in childbearing mothers with a healthy newborn baby (Brunner et al., 1994; Gay, Lee, & Lee, 2004; Lee, McEnany, & Zaffke, 2000; Shinkoda, Matsumoto, & Park, 1999). Postpartum fatigue severity has been found to be associated with fragmented sleep patterns (Lee & Zaffke,1999), and impaired sleep can lead to a wide array of negative physical and mental health outcomes (Lee, 2003).

In contrast to mothers with healthy newborns, mothers of medically ill infants are at increased risk for impaired sleep due to stress related to the uncertain health of the infants (Lee, Lee, Rankin, Alkon, & Weiss, 2005; Lee, Lee, Rankin, Weiss, & Alkon, 2007). In addition, the potential for extended periods of exposure to the artificial dim light in the neonatal intensive care unit (NICU) may exacerbate maternal sleep disruption due to desynchronized circadian rhythms. To date, few studies have documented sleep measures in mothers whose infants have medical problems at birth, and limited information is available on the symptoms and healthrelated quality of life associated with impaired sleep including fatigue, depressive symptoms, and poor physical health.

Using baseline data from a pilot study of a randomized clinical trial, we explored relationships between impaired sleep and well-being in mothers with a low-birth-weight (LBW) infant hospitalized in the NICU. The following research questions were addressed: What are sleep patterns of mothers of LBW infants in the NICU during early postpartum period? What is the relationship between objective and subjective sleep measures and maternal well-being (fatigue, depressive symptoms, and health-related quality of life)? What is the relationship between objective and subjective sleep measures and amount of light exposure? What is the relationship between circadian activity rhythms (CAR) and maternal well-being?

Review of the Literature

The number of LBW infants has steadily increased since 1984 (Martin et al., 2003). Low birth weight is defined as less than 2,500 g (5.5 lb). Compared to full-term infants, LBW infants spend a significantly longer time in hospitals, have more outpatient visits, and have more medical needs (Rogowski, 1998). Impaired sleep and fatigue are common throughout pregnancy; thus, mothers enter the postpartum period with vulnerabilities related to sleep and rest. Impaired sleep was implicated in reports of diminished well-being of new mothers during the postpartum period more than four decades ago (Karacan, Williams, Hursch, McCaulley, & Heine, 1969), and this finding has been replicated in recent studies (Gay et al., 2004; Hiscock & Wake, 2001). Most existing studies, however, have focused on mothers with healthy newborns. Thus, limited information is available on sleep and well-being among mothers with an infant hospitalized in the NICU (Lee & Lee, 2007; Lee et al., 2007).

Maternal Fatigue

Fatigue is a subjective sensation and has been found to be a strong predictor of postpartum depressive symptoms (Corwin, Brownstead, Barton, Heckard, & Morin, 2005; Dennis & Ross, 2005) and is associated with maternal quality of life (Jansen et al., 2007). Studies have documented morning fatigue at a 4.9 level on a 0 to 10 scale for mothers with a healthy newborn (Gay et al., 2004) and a 5.3 level for mothers with an infant in the NICU (Lee et al., 2005) during the first month postpartum. These two studies also showed that severity of maternal evening fatigue was worse than morning fatigue. Mothers of premature or medically ill infants also experienced psychological distress (Holditch-Davis & Miles, 2000; Miles, Wilson, & Docherty, 1999), and as a result, mothers may suffer impaired sleep, fatigue (Lee & Lee, 2007; Lee et al., 2007), and depression (Weiss & Chen, 2002).

Sleep and Well-Being

Sleep is a fundamental human need and provides for physical and psychological restoration. According to the two-process model of sleep regulation (Borbely, 1982), normal sleep/ waking is determined by interactions between the homeostatic process (drive for sleep) and circadian process (drive for wakefulness; Mignot, Taheri, & Nishino, 2002; Vitaterna, Takahashi, & Turek, 2001). Adequate sleep, for a healthy adult, is defined as falling asleep within 5 to 10 minutes after the light is off, nighttime total sleep time (TST) of no less than 7 hours/day, staying asleep for at least 90% of the time in bed, and feeling refreshed after awakening (Lee, 2003; Sateia, Doghramji, Hauri, & Morin, 2000). The dim lights of the NICU are designed to minimize stimulation and promote the premature or sick infant's development and healing; however, this environment may lead to circadian phase desynchronosis for adults. While light exposure within and between different NICUs may vary, there is concern that mothers spending extended periods of time with their infants in the NICU may be at risk for disruptions in their circadian rhythms. Moreover, the stress of having an infant hospitalized in NICU may also deteriorate mothers' sleep quality and quantity (Lee et al., 2005, 2007).

Recent studies examining the well-being of postpartum mothers found that sleep disturbance and depression both contributed to insomnia (Ross, Murray, & Steiner, 2005). As a result of the insomnia, postpartum mothers experienced daytime fatigue and sleepiness that negatively affected nighttime sleep. Women with postpartum depression (PPD) experienced poorer sleep than women without PPD (Posmontier, 2008), and they reported adverse health outcomes (Brown, Lumley, McDonald, & Krastev, 2006; Da Costa, Dritsa, Rippen, Lowensteyn, & Khalife, 2006). Maternal fatigue level has also been identified as a predictor of PPD symptoms (Corwin et al., 2005; Dennis & Ross, 2005).

Circadian Activity Rhythms and Well-Being

Circadian rhythms influence sleep and wakefulness. Several environmental cues, such as light, meals, and social cues, help to regulate circadian rhythms, with light as the most powerful factor. Exposure to sunlight helps to set circadian cycles so they are consistent from day to day. Lack of exposure to bright light has negative effects on the body's sleep-wake cycle (Kuller, 2002). In general, mothers with infants in NICU will visit their infants daily, and these environmental factors may interrupt circadian rhythms. Circadian activity rhythms and light exposure levels have been found to be related to the severity of dementia (Ancoli-Israel, Clopton, Klauber, Fell, & Mason, 1997; Gehrman et al., 2005) and seasonal affective disorder (Winkler et al., 2005). However, studies exploring the relationships between CAR, light exposure, and well-being in postpartum women are rare. Thus, addressing these relationships in postpartum mothers with an infant in the NICU may result in greater understanding of maternal physical and psychological health and how to optimize interventions for mothers with infants in the NICU.

Methods

Study Design and Participants

This article reports the baseline data from a pilot of a randomized clinical trial that tested the feasibility of a sleep intervention, including bright light therapy, to improve sleep and well-being (fatigue, depressive symptoms, and health-related quality of life) in mothers of LBW infants. Only cross-sectional, baseline (pretreatment) data are presented here. Permission to conduct the study was obtained through the University's Committee on Human Research and through Institutional Review Boards at hospital recruitment sites.

Twenty first-time mothers in the second week postpartum in metropolitan Atlanta, GA, consented to participate. Mothers were included if they were at least 18 years old and had given birth to an LBW infant (less than 2,500 g) for whom hospitalization in the NICU for a minimum of 5 weeks was anticipated. Mothers were excluded from participating for any of the following reasons: history of an affective illness such as depression or bipolar disease; current use of medications that might alter sleep (e.g., any central nervous system stimulants, depressants, or antidepressant medication); employment as a shift worker whose circadian rhythm might already be disrupted; history of a diagnosed sleep disorder such as sleep apnea or nighttime myoclonus, which might give a higher waking time score from the overnight wrist actigraphy monitoring; extended hospitalization period of more than 3 days for vaginal birth mothers and more than 7 days for Cesarean birth mothers.

Tables 1 and 2 summarize the clinical and demographic characteristics of the participants. Mothers' ages ranged from 18 to 34 years ($M = 23.6 \pm 5.5$) with a majority being Black (75%). Most of the mothers were lower income, were married or partnered, and had an average educational level of 13.4 ($SD = 2.8$) years. The Clinical Risk Index for Babies score (The International Neonatal Network, 1993) was adopted to assess the infants' morbidity levels, with 80% of the infants classified as low morbidity. Mothers were also asked to rate their infant's illness condition at admission and again at the time of the interview on a scale ranging from 1 =*not sick at all*) to 5 = *extremely critical*. The majority of mothers (70%) rated their infant's severity of illness as severe to extremely critical at admission, and 50% of the mothers rated their children as moderate at the time of the interview.

Instrumentation

Subjective/Objective Sleep and Light Measurement—The General Sleep Disturbance Scale (GSDS) was used to measure subjective sleep disturbance. The GSDS is a 0 to 7 weekly rating scale and includes 21 items related to frequency, in the most recent week, of difficulty getting to sleep (1 item), waking up during sleep (1 item), waking up too early from sleep (1 item), quality of sleep (3 items), quantity of sleep (2 items), fatigue and alertness at work (7 items), and use of substances to help induce sleep (6 items). Higher scores indicate more severely disturbed sleep (Lee, 1992). Cronbach's α for the overall scale was reported as .88; for the subscales of sleep quality and daytime sleepiness, αs were .79 and .82, respectively. Evidence for construct validity of the instrument using the modified Stanford Sleep Questionnaire Assessment of Wakefulness has been reported (Lee). Consistent with the DSM-IV criteria for insomnia symptoms, which specify frequency to be at least three times per week, a mean score of 3 on the total GSDS or any of the subscales is considered a clinically significant sleep disturbance (Lee). The Cronbach's α coefficient for the overall scale was .80 in the current study.

Objective sleep, including nighttime TST, wake after sleep onset (WASO), and light exposure were measured with wrist actigraphy, using a light sensor that registers illumination ranging from 1 to 40,000 lx (Mini Motionlogger Actigraphy, octagonal motionlogger, Ambulatory Monitoring Inc., Ardsley, NY). This waterproof actigraph, which is similar to a wristwatch, uses a battery-operated, wristwatchsize microprocessor that senses motion with a piezoelectric beam and detects movement and acceleration in all three axes. An event marker can be used to indicate bedtime (light off time) and rising time (light on time). One-minute sampling intervals were used in this study to calculate TSTand WASO. Various researchers have used polysomnographic measures of sleep to validate wrist actigraphy as a measure of TST and WASO during the night (r = .93-.99; Ancoli-Israel et al., 1997; JeanLouis et al.,1996). Registered lux levels are averaged across each minute and stored in memory. The light sensors are precisely calibrated in a light chamber against a gold-standard lux sensor. To facilitate interpretation of the actigraph data, mothers recorded their sleep-wake patterns in 48 hour slepp diares.

Fatigue—A 7-item Numerical Rating Scale-Fatigue (NRS-F) was included in the sleep diary to measure fatigue severity in the morning (rising time) and evening (right before bedtime). The NRS-F (Lee, Hicks, & Nino-Murcia, 1991) includes a 13-item fatigue subscale and 5-item energy subscale, ranging from 0 = *not fatigued* to 10 = *extremely fatigued*. To reduce participant burden, only 7 of the 13 fatigue subscale items were used in this study. There are no existing data on clinically significant change for this particular scale. However, a mean score of 3.3 or less indicates minor fatigue levels (Lee et al.). The Cronbach's α coefficients for the shorter 7-item version of the fatigue scale ranged from .86 to .96 for the two morning and two evening measures in this sample.

Maternal Well-Being—Depressive symptoms and health-related quality of life were used to measure maternal well-being. Depressive symptoms were measured with the Edinburgh Postnatal Depression Scale (EPDS; Cox, Holden, & Sagovsky, 1987). The EPDS is a 10-item, 4-point scale to assess the severity of depressive symptoms over the past week, from 0 = *rarely or none* to 3 = *most or all of the time*. Higher scores indicate more depressive symptoms, and a score of 13 or above is indicative of postpartum depressive symptoms. The Cronbach's α coefficient for the overall scale was .86 in the current study.

Health-related quality of life was measured with the Medical Outcomes Short Form-36, version 2 (SF36v2), a 36-item questionnaire that covers eight domains of physical and mental health and has demonstrated reliability and validity (McHorney, Ware, Lu, & Sherbourne, 1994; Ware & Sherbourne, 1992). According to standardized scoring protocols, the raw scores were transformed to Z scores using the norms of the U.S. population in 1998.

The scale has been widely used in clinical and normal populations and has been used to assess quality of life in postpartum women (de Tychey et al., 2008; Jansen et al., 2007). A higher score indicates better health status and higher health-related quality of life.

Data Collection

Mothers were identified via NICU census data and approached about participating in the study in the NICU waiting area. After written informed consent, mothers were asked to wear the wrist actigraphy monitor for 48 hours (completed during the second week of postpartum), and were instructed to press the ‘‘event marker button’’ to indicate light off (bed-time) and light on (rising time) times. The actigraphy monitor was worn for 48 consecutive hours during weekdays of the second postpartum week. The research assistant provided the actigraphy monitor to participants at the appropriate time to assure consistency of data collection periods among participants. Mothers were also asked to keep a 2 day sleep diary while they wore the wrist actigraph to record their sleep-wake patterns and their morning and evening fatigue levels. Mothers completed a brief booklet after 2 days of sleep monitoring that included questionnaires to report their subjective perceptions of sleep, depression, and well-being.

All data were collected over a 2 day period. Actigraphy and fatigue data were collected for 2 days and data reported for these instruments (objective sleep and activity) and morning and evening fatigue represent the average value for the 2 days. Questionnaire data about subjective perceptions of sleep, depression, and well-being were collected at one time point after participants completed their actigraphy monitoring.

Data Analysis

Data were double-entered into a data file using Statistical Package for the Social Sciences 16.0 for analysis. The automatic sleep-scoring program (Action 4 Software Program) was used to calculate TSTand WASO. Total sleep time and WASO were not significantly different between the two nights; therefore, mean values for the two nights were used in the final analysis. To examine the CAR, cosinor analysis was used (Ancoli-Israel et al., 2003) in which a cosine curve with a period at or near 24 hours is fit to the data by the least-squares method to determine the daily activity relationships during the monitoring period. The mesor (fitted activity mean), the acrophase (time of the peak of the fitted activity curve), and the amplitude (magnitude of the activity oscillation) were determined using the Action 4 software to evaluate the CAR.

Descriptive statistics were used to characterize the sample and describe study variables. Data were examined to assure assumptions for the selected statistics methods were met. Pearson’s correlations were used to examine relationships between objective and subjective measures of sleep, light exposure, CAR, fatigue, depressive symptoms, and physical and mental health-related quality of life.

Results

Sleep and Fatigue

General data about sleep history and breast feeding were obtained with the demographic information. A majority of the mothers reported experiencing sleep problems during their pregnancy (85%) and after delivery (80%). Although all of the mothers were pumping their breast milk for their hospitalized infants, according to their sleep diaries, none of the mothers reported the need to pump breast milk as the reason for their nighttime awakenings. The selfreported sleep disturbances and fatigue severity questionnaire data are presented in Table 3 using means and standard deviations. Mothers reported a moderate fatigue severity, and their evening fatigue ratings were significantly higher than morning fatigue ($p = .002$). The overall mean score of the GSDS was 2.73 (*SD* =.86), which is slightly below the cut-offof 3, indicating mothers were experiencing clinically significant poor sleep. Mothers also reported poor sleep quality and disturbed daytime function, which were only slightly above the cut-off for clinical significance. General Sleep Disturbance Scale total scores were significantly correlated with both morning and evening fatigue scores (Table 4), indicating greater total sleep disturbance was associated with greater morning and evening fatigue.

Nighttime sleep as recorded by wrist actigraphy (Table 3) was less than 7 hours and was significantly less than what mothers reported as necessary to restore their energy, paired $t[19] = 2.5$, $p = .02$. Compared to a normal adult, mothers in the sample took longer to fall asleep (17 minutes) and had a longer WASO (18.8%). The average daytime sleep as recorded by wrist actigraphy during the 12 hour day period was more than 1 hour, and was negatively correlated with the nighttime TST ($r < -.53$, $p = .02$), which indicates mothers who had more sleep debt from the nighttime also had more daytime sleep.

Sleep, Depressive Symptoms, and Health-Related Quality of Life

The EPDS was used to measure depressive symptoms, and the SF36v2 for health-related quality of life (physical and mental health components). Data are presented in Table 3 using means and *SD*s; the norm scores are also included. Mothers experienced a moderate level of depressive symptoms, which were higher than normal, and their physical and mental health were about 1.0 *SD* below the normative scores for age-matched females in the U.S. general population.

Mothers who reported greater sleep disturbances on the GSDS had significantly lower mental health-related quality of life as measured by SF36v2. The correlation between sleep disturbance and depressive symptoms was in the expected direction but was not statistically significant (Table 4). No statistically significant relationship was found between the nighttime TST measured by the wrist actigraph, depressive symptoms, or health-related quality of life. Since TST needed by each person is very individualized, we further explored the relationship between sleep debt (the differences betweenTST needed by mothers to feel refreshed and actual TST measured from wrist actigraph) and the health outcomes. Mothers who had more sleep debt reported more fatigue severity and depression and poorer physical and mental health. Sleep quality could be negatively impacted by interrupted sleep maintenance; thus WASO was also used to explore the relationships between objective sleep quality and health outcomes, and findings were consistent with relationships between TST, sleep debt, and health outcomes. However, an unexpected relationship was found between WASO and depressive symptoms and mental health. In this small study, mothers who wake up more after sleep onset reported less depressive symptoms and better mental health.

Light Exposure and Sleep

The average 12 hour light exposure levels after the mothers' waking time were used for the final data analysis. The light level in a brightly lit office is about 400 to 500 lx; for study participants, however, the 12 hour light exposure levels ranged from 3.4 to 218 lx and averaged about 73.4 lx (*SEM* = 12). Light exposure levels were significantly negatively correlated with a mother's perception of her infant's vulnerability at birth ($r = -.63$, $p < .01$). It is possible that mothers with more vulnerable infants or who perceive their infant to be vulnerable may spend more time in the darker environment (e.g., NICU); however, this could not be confirmed, since data were not collected on the amount of time mothers spent in the NICU or the light exposure obtained during these visits. Mothers who had greater average 12 hour daytime light exposure levels reported less sleep disturbances from the GSDS ($r = -.31$), and less daytime functioning disturbance ($r = -.36$) from the GSDS subscale. When compared to data measured from the wrist actigraph, we found that a negative relationship between light exposure and WASO ($r = -.20$) indicated a trend that more light exposure may lead to less awakening time after sleep onset. A negative relationship between light exposure and TST ($r = -.51$, $p < .05$) was observed; however, we also found those who had higher light exposure also got up earlier ($r = -.51$, $p < .05$). Using the variable sleep debt to explore a possible explanation for this unexpected finding, we found those who had higher light exposure also had less sleep debt. Moreover, better physical health ($r = .65$, $p = .02$) and mental health ($r = .23$) were found from those mothers exposed to higher light levels.

Circadian Activity Rhythms and Well-Being

Cosinor analysis was used for computing the CAR. The average amplitude was 90 (*SD* = 19.7), the mesor was 129.9 (*SD* = 20.2), and the acrophase in military time format was 16:44 (*SD* = 1:06) for mothers in this study. The later acrophase indicates more circadian phase delay (Ancoli-Israel et al., 1997). A statistically significant strong positive correlation was found between acrophase and mother's rising time ($r = .79$, $p < .001$), indicating that mothers with a later acrophase had a later awake time. Mothers who had a higher amplitude also had a longer nighttime TST ($r = .53$, $p < .02$) indicating that mothers with a higher activity level had a longer nighttime sleep. Amplitude could be affected by robust rhythm and vigorous activity, which means mothers with more robust rhythms or who moved more vigorously might have higher amplitude scores. Thus, to characterize the strength of the circadian rhythm the circadian quotient was calculated by dividing the amplitude by the mesor, which provides a normalized value that allowed comparison between individuals; the larger the quotient, the better the rhythms (Ancoli-Israel et al., 1997, 2003).

The average circadian quotient for the mothers in this sample was .70 (*SD* =.14) with a median of .75. To date, no circadian quotient data have been reported for postpartum women with either normal weight or LBW infants. However, an average circadian quotient of .52

(*SD* =.29) has been reported for elderly patients with severe dementia (Ancoli-Israel et al., 1997) and an average circadian quotient of .51 (*SD* =.03) has been reported for a group of middle-aged Holocaust survivor's offspring whose parents suffered posttraumatic stress disorder (Yehuda et al., 2007). The circadian quotient was statistically positively correlated with the nighttime TST ($r = .84$, $p < .001$), and was negatively correlated with the total daytime sleep ($r = -.59$, $p < .01$). These findings indicate that mothers with better CAR had more nighttime sleep and less daytime sleep. No significant relationship between the circadian quotient and well-being was found. However, there was a trend showing a positive relationship between the circadian quotient and better physical and mental health.

Discussion

Research reporting relationships between maternal sleep and well-being during the hospitalization of a critically ill infant is limited, and none has included a measure of light exposure or CAR. The results of this study showed that mothers of hospitalized LBW infants experienced clinically significant sleep disturbance. The results are comparable to previous findings for mothers with a medically ill infant cared for in the ICU (Lee et al., 2005) and mothers with a well baby during the first month of postpartum (Gay et al., 2004). Mothers in the current study slept almost 1 hour less than what they reported needing to feel refreshed. Sleep was disturbed, despite the fact that their infant was being cared for in the NICU and mothers were not having to provide child care during nighttime at home. Specifically, women reported disturbed sleep quality and daytime functioning and experienced clinically significant fatigue severity in both morning and evening. The results of this study indicated that both morning and evening fatigue levels were associated with mother's perceived sleep disturbance and the duration of nighttime awakening time.

Compared to the norms, mothers in this sample had more depressive symptoms and lower healthrelated quality of life. The lack of statistically significant correlation between the objective sleep measurement and well-being might be related to the wrist actigraphy monitoring time, which was only 2 days. Further research is needed, which follows the evolution of the postpartum objective sleep characteristics and maternal well-being over a longer period of time. However, it is very interesting to find that mothers in the current study who had higher WASO experienced less depressive symptoms and better mental health but not physical health. The relationships observed could have occurred by chance. However, it is also possible that those mothers who experienced more depressive symptoms had more disturbed sleep ($r = .40$) and had more sleep debt ($r = .15$), thus, resulting in less awakening during nighttime ($r = -.25$).

The level of light exposure was statistically significantly correlated with fewer self-reported disturbances in the area of sleep quantity. The CAR determined by the circadian quotient was correlated with more nighttime TST, less daytime sleep, and fewer depressive symptoms. Research is limited about postpartum CAR and how the experience of having an LBW infant influences circadian rhythms. For example, it is unknown how having an infant in the NICU may negatively affect mothers' environmental cues that entrain circadian rhythms such as social activities and other daily life events.

Previous studies have shown that mothers of medically fragile infants are at risk for depressive symptoms during the first year of the infant's life (Miles, Holditch-Davis, Burchinal, & Nelson, 1999) and that maternal depression predicts infant growth restriction (Rahman, Iqbal, Bunn, Lovel, & Harrington, 2004). These findings suggest that new mothers who have an LBW infant hospitalized in a NICU were vulnerable, as they experienced morning and evening fatigue, depressive symptoms, and sleep disruption. Poor sleep and these associated symptoms have the potential to affect a mother's ability to perform her new maternal role and may ultimately negatively affect her relationship with the infant (Hiscock & Wake, 2001). Thus, developing interventions to promote maternal sleep and well-being are warranted.

These findings also support a relationship between light exposure and sleep quantity. We did not ask mothers how many hours they spent in the NICU with their infants, so it is unknown if lower levels of light exposure observed in the sample were related to prolonged visitation with their infants. However, the average light exposure level measured by wrist actigraph was low in this group of mothers and may negatively affect their sleep and well-being (National Sleep Foundation, 2005). Therefore, the relationship among light exposure and mothers' sleep and health outcomes warrants further research.

Limitations

This study included a small sample from one region of the United States and data were collected at one point in time; thus the findings should be interpreted with caution. Further research should include replicating the study in a larger, more ethnically diverse sample of women and examining maternal sleep and health outcomes over time, both during the infant's hospitalization period and after the infant is discharged to home. The period for objectively measuring sleep was limited to 48 hours in this study and this may have attenuated correlations between subjective and objective sleep measures. Extending the objective sleep measurement time period would be useful; however, to prevent burdening the vulnerable mothers, a minimum of 3 days monitoring, as suggested by the American Academy of Sleep Medicine should be adopted.

Conclusion

Promoting sleep during the early postpartum period remains an important part of improving childbearing women's quality of life (Huang, Carter, & Guo, 2004). However, studies focusing on mothers with a hospitalized infant are not as common as studies of mothers with a healthy newborn. The relationships between sleep, CAR, light exposure, and well-being among this specific subgroup of mothers need to be objectively further explored with a prolonged monitoring time period. To date, no intervention studies testing a strategy for improving mothers' sleep following the birth of a critically ill infant have been found in the literature. Currently, the standard of care for parents with an infant in the NICU includes providing information and supporting coping strategies. However, specific information about promoting sleep in mothers is often neglected in the standard of care. Lack of sufficient sleep may not only increase daytime fatigue but also inhibit the cognitive functioning necessary for new parents to understand their infant's health problems and participate in caretaking during their infant's hospitalization and subsequent hospital discharge. This study also highlights that the relationships between depressive symptoms, mental health, subjective experiences of sleep, and light exposure are complicated. Studies with larger sample sizes will be necessary to guide interventions, specifically whether the focus of the intervention should be primarily on reducing depressive symptoms, improving sleep, increasing light exposure, or a combination of these strategies. Ultimately, improving maternal sleep and well-being in mothers of infants cared for in the NICU should support healthy mother-infant relationships.

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Table 1:

Maternal Demographics (*N* = 20)

Age	23.6 (*SD* = 5.5)
Years in school	13.4 (*SD* = 2.8)
Ethnic group	
White	4 (20%)
Black	15 (75%)
Hispanic	1 (5%)
Income	
Up to $20,000	8 (40%)
$20,001–40,000	6 (30%)
$ 40,001–60,000	2 (10%)
$ 60,001–80,000	2 (10%)
Not reported	2 (10%)
Sleep problems during pregnancy	
Yes	17 (85%)
No	3 (15%)
Breastfeeding	
Yes	20 (100%)
Marital status	
Married	5 (25%)
Separated	1 (5%)
Living with partner	7 (35%)
Single	7 (35%)

Table 2:

Demographic Characteristics of the Babies ($N = 20$)

Gestational age	
24–29 weeks	15 (75%)
30–36 weeks	5 (25%)
Gender	
Boy	12 (60%)
Girl	8 (40%)
Severity of illness rated by CRIB	
Low risk	16 (80%)
Mildly ill	4 (20%)
Infant's morbidity perceived by mothers (at birth/at interview)	
Not severe at all	2 (10%)/2 (10%)
Minor	2 (10%)/4 (20%)
Moderate	2 (10%)/10 (50%)
Severe	8 (40%)/4 (20%)
Extremely critical	6 (30%)/0 (0%)

Note. CRIB = Clinical Risk Index for Babies score.

Table 3:

Description of Subjective and Objective Measurements

Variables	**Means and *SD***	**Normal Range**
Sleep time needed by mothers to feel refreshed	459 min (*SD* = 71)	420–480 min
Subjective sleep		
GSDS total scale	2.7 (*SD* = 0.8)	<3
Sleep quality	3.9 (*SD* =1.9)	<3
Daytime	3.5 (*SD* =1.3)	<3
functioning		
Objective sleep and activity measured by wrist actigraph (2 days average)		
Nighttime TST	403 min (SEM = 20.1)	420–480 min
Daytime TST	69.5 min (SEM = 15.2)	<30 min
Sleep latency	17 min (SEM = 2.8)	<15 min
Wake after sleep onset	18.8% (SEM = 2.2%)	<10%
Duration of each awake time	5.6 (SEM = 0.8)	
Amplitude	90 (*SD* =19.7)	Not available
Mesor	129.9 (*SD* = 20.2)	Not available
Acrophase (time format)	16:44 (*SD* = 1:06)	13:00–7:00
Circadian quotient	0.70 (*SD* = 0.14)	Not available
Depression		
EPDS	14.7 (*SD* = 5.6)	<10
Fatigue (2 days average)		
Morning	3.7 (*SD* = 1.9)	<3.3
Evening	5.1 (*SD* = 1.5)	<3.3
Medical outcomes		
SF36v2PCS	−0.87 (*SD* = 0.9)	
SF36v2MCS	−1.26 (*SD* = 1.15)	
Light exposure		Office light level
12 hours' average	73 lux (SEM = 14)	400–500 lx

Note. EPDS 5 Edinburgh Postnatal Depression Scale, GSDS 5 General Sleep Disturbance Scale, SF36MCS 5 Medical Outcomes Short Form-36 version2-Mental Health Summary, SF36PCS 5 Medical Outcomes Short Form-36 version 2-Physi-cal Component Summary, TST 5 total sleep time.

Table 4:

Correlations Between Sleep, Light Exposure and Well-Being ($N = 20$)

	NRS-MF	NRS-EF	EPDS	SF36PCS	SF36MCS	12 hours' light exposure
GSDS	.52*	.51*	.40	−.40	−.53*	− 0.31
Sleep quality	.37	.54*	.38	−.14	−.55*	− 0.07
Daytime function	.55*	.52*	.29	−.45*	−.48*	− 0.36
TST	.12	.06	.03	−.28	.02	− 0.51*
WASO	−.24	−.18	−.26	−.24	.20	− 0.20
Sleep debt	.48*	.30	.15	−.07	−.17	− 0.33
12 hours' light exposure	−.40	−.20	−.19	.65**	.23	1.00

Note. EPDS 5 Edinburgh Postnatal Depression Scale, GSDS 5 General Sleep Disturbance, NRS-EF 5 Numerical Rating Scale-Evening Fatigue, NRS-MF 5 Numerical Rating Scale-Morning Fatigue, SF36MCS 5 Medical Outcomes Short From-36 version2-Mental Health Summary, SF36PCS 5 Medical Outcomes Short Form-36 version 2-Physical Component Summary, sleep debt 5 total sleep time reported by mothers to feel refreshed minus total sleep time measured by actigraph, TST 5 nighttime total sleep time monitored from wrist actigraph, WASO 5 wake after sleep onset in minutes.

* p<.05.

** p<.01.